

ENGINEERING SPECIFICATION

FOR

SEISMIC PROTECTION OF EQUIPMENT

PUEBLO CHEMICAL AGENT-DESTRUCTION PILOT PLANT (PCAPP) PROJECT



QUALITY LEVEL: Q Non-Q N/A

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			Sheet 1 of 11				

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1 SCOPE

The purpose of this specification is to establish the minimum seismic design requirements for the PCAPP Project. In addition, equipment categorized as Seismic Category I shall meet seismic qualification requirements per Section 4 of this specification.

Acronyms used are as follows:

APB: Agent Processing Building
 ERB: Enhanced Reconfiguration Building

The party furnishing the equipment shall be referred to as the Seller and the Bechtel Pueblo Team member purchasing the equipment shall be referred to as the Buyer.

1.1 WORK INCLUDED

The work shall include the design of seismic anchorage for all equipment and the seismic qualification for Seismic Category I equipment.

1.2 WORK NOT INCLUDED

The work shall not include the furnishing of equipment anchor bolts.

1.3 DEFINITIONS

Seismic Category I – Seismic Category I equipment, including supports, shall withstand seismic loads in conjunction with other loads without loss of structural integrity.

Seismic Category II – Seismic Category II equipment includes all equipment that is not Seismic Category I.

2 APPLICABLE DOCUMENTS

The following documents form part of this specification to the extent specified herein. In the event of a conflict between the referenced document and the contents of this specification, the Buyer shall be notified to resolve the conflict.

2.1 CODES AND STANDARDS

ACI	American Concrete Institute
ACI 318/318R-05	Building Code Requirements for Structural Concrete and Commentary
AISC	American Institute of Steel Construction
AISC 316-89	Manual of Steel Construction, Allowable Stress Design, Ninth Edition

ASCE	American Society of Civil Engineers
ASCE 7-02	Minimum Design Loads for Buildings and Other Structures
ASTM	American Society for Testing and Materials
ASTM A 36/A 36M-05	Standard Specification for Carbon Structural Steel
ASTM A 307-04	Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 325-04b	Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 563-04a	Standard Specification for Carbon and Alloy Steel Nuts
ASTM F 436-04	Standard Specification for Hardened Steel Washers
ASTM F 1554-04	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
AWS	American Welding Society
AWS D1.1/D1.1M-04	Structural Welding Code – Steel
ICC	International Code Council
IBC	International Building Code, 2003

2.2 OTHER DOCUMENTS

24852-RD-30X-000-M0001	Master Equipment List
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3 SEISMIC ANCHORAGE DESIGN

The equipment for the PCAPP project can be classified into the following two categories:

- Mechanical and electrical components as listed in ASCE 7, Table 9.6.3.2
- Tanks, vessels, and other nonbuilding structures as listed in ASCE 7, Table 9.14.5.1.1

The equipment support conditions can be classified into the following three categories:

- Equipment supported on grade
- Equipment supported on elevated concrete floors or roofs
- Equipment supported on steel platforms or roofs

For equipment supported on concrete slabs, the Seller shall design the anchorage using post-installed anchors. Post-installed anchors may be either adhesive anchors or expansion anchors except that expansion anchors shall not be used in the APB and ERB. Design of expansion anchors shall be in accordance with ACI 318/318R, Appendix D. Design of adhesive anchors shall be in accordance with manufacturers' specifications. However, allowable design loads for adhesive anchors shall not be greater than values listed in applicable ICC evaluation reports. Material for post-installed anchors shall be in accordance with manufacturers' specifications. One ASTM F436 washer shall be placed between the nut and the anchor plate.

If necessary, cast-in-place anchors may be used for equipment supported on concrete slabs. Material for cast-in-place anchors shall be ASTM F1554 or A307 with A563 heavy hex nuts, grade DH. One ASTM F436 washer shall be placed between the nut and the anchor plate.

For equipment supported on structural steel, anchorage design (bolting or welding) shall be based on AISC 316. Structural bolting material to structural steel shall be ASTM A325, Type 1 with A563 heavy hex nuts, grade DH. The connection shall be bearing type. One ASTM F436 washer shall be placed under the element turned in tightening. Welding electrodes shall be E70xx.

3.1 SEISMIC FORCE DETERMINATION

The methodology for determining seismic design forces for equipment is based on the IBC.

Seismic anchorage forces shall be determined in accordance with IBC, Section 1621 for the equipment types listed in ASCE 7, Table 9.6.3.2, and IBC, Section 1622 for the equipment types listed in ASCE 7, Table 9.14.5.1.1.

The combined effects of horizontal and vertical seismic forces shall be included based on IBC, equations 16-50 and 16-51.

Seismic Category I equipment includes selected Q equipment plus essential and critical power equipment. Seismic Category II equipment includes all other equipment. Seismic anchorage forces for Seismic Category I equipment are larger than the seismic anchorage forces for Seismic Category II equipment as specified below.

The tables below provide necessary coefficients specific to this project.

Seismic Category	I, I _p
I	1.5
II	1.0

Seismic Category	S _{DS}	S _{D1}
I	0.276	0.089
II	0.246	0.079

For light equipment (less than 5,000 lbs), the forces listed below may be used in lieu of using the code sections given above. Note that equipment mounted on vibration isolation systems shall have bumper restraints or snubbers in each horizontal direction and the seismic anchorage force shall be twice the value listed below.

For equipment supported on grade (based on strength design):

Seismic Category	Mechanical and Electrical Components	Nonbuilding Structures
I	E = 0.43W (horizontal) E = 0.07W (vertical)	E = 0.33W (horizontal) E = 0.06 (vertical)
II	E = 0.26W (horizontal) E = 0.06W (vertical)	E = 0.20W (horizontal) E = 0.05 (vertical)

For equipment supported on elevated concrete floors or roofs (based on strength design):

Seismic Category	Mechanical and Electrical Components	Nonbuilding Structures
I	E = 0.86W (horizontal) E = 0.07W (vertical)	N/A
II	E = 0.51W (horizontal) E = 0.06W (vertical)	N/A

For equipment supported on steel platforms or roofs (based on allowable stress design):

Seismic Category	Mechanical and Electrical Components	Nonbuilding Structures
I	E = 0.46W (horizontal) E = 0.04W (vertical)	N/A
II	E = 0.28W (horizontal) E = 0.03W (vertical)	N/A

3.2 ANCHORAGE FORCE DETERMINATION

Seismic anchorage forces shall be combined with the anchorage forces from other loads based on criteria provided in the Purchase Specification.

4 SEISMIC QUALIFICATION OF EQUIPMENT

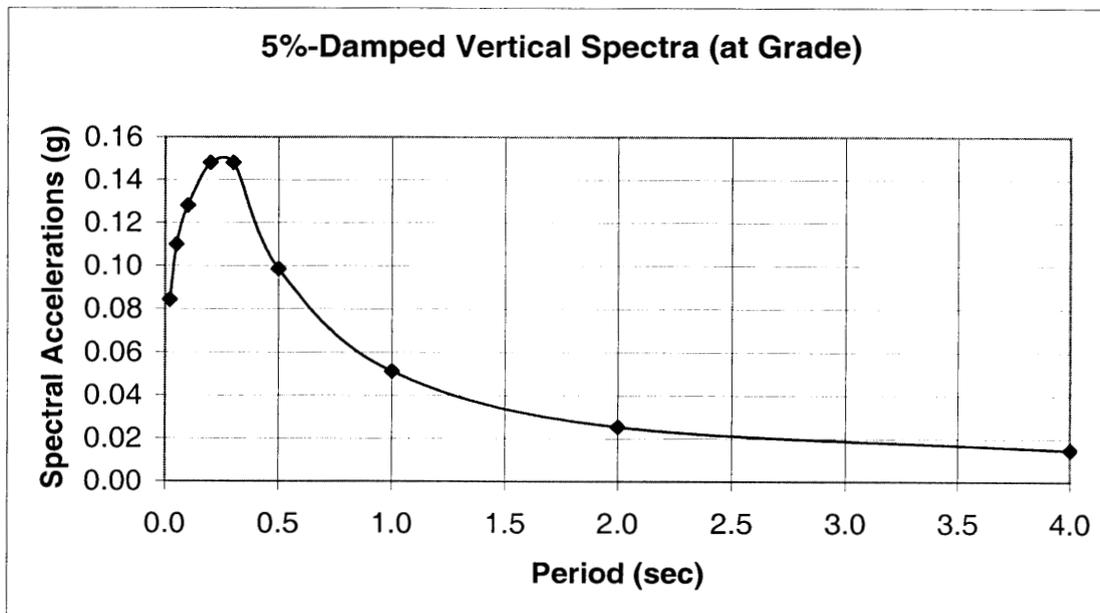
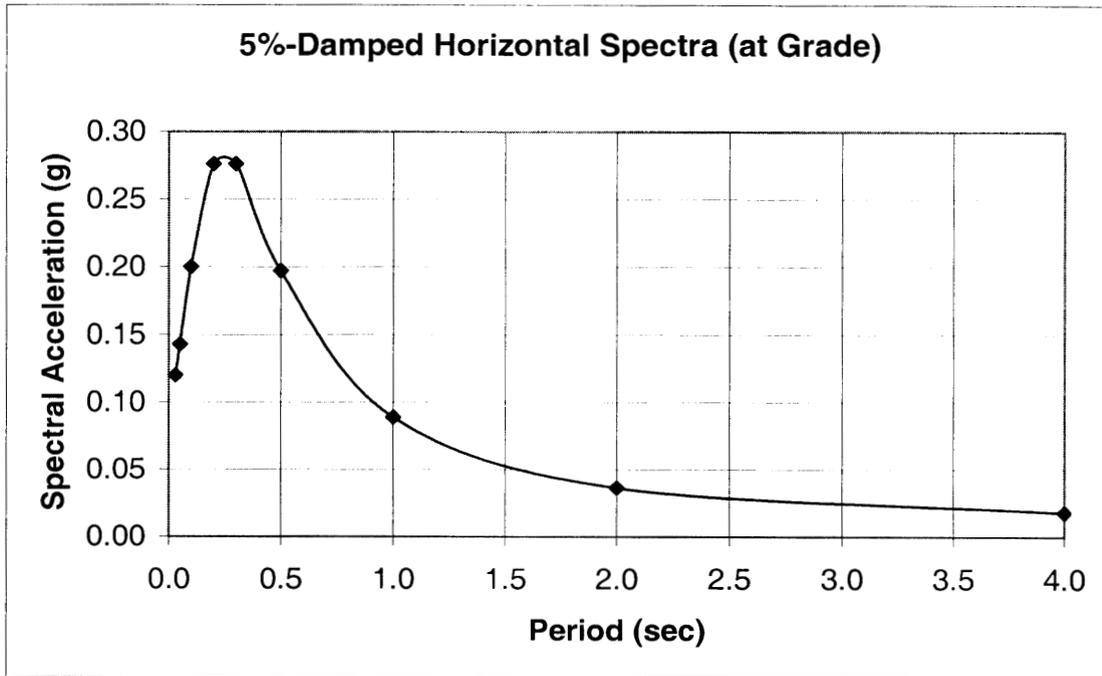
The requirements for the seismic qualification of equipment shall apply to equipment identified as Seismic Category I. Document No. 24852-RD-30X-000-M0001 includes the seismic category for all equipment. The equipment, including supports, shall withstand seismic loads in conjunction with other applicable loads without loss of structural integrity.

Seismic qualification of equipment shall be accomplished by using one of the analysis methods prescribed below. Dynamic testing (proof of operability) of equipment is not required.

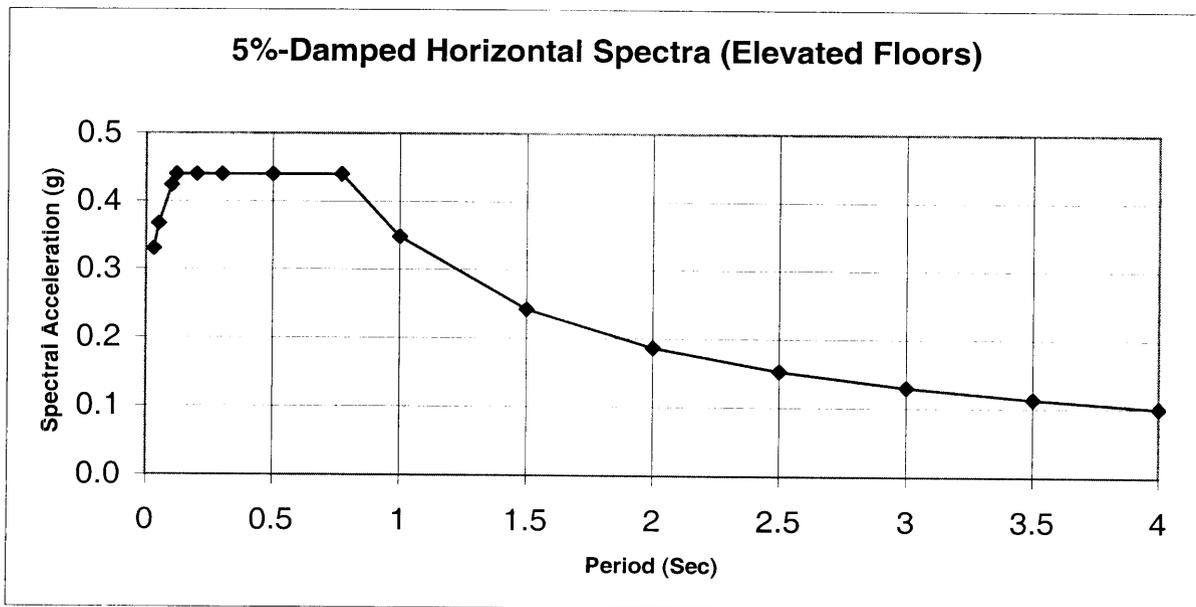
4.1 DYNAMIC ANALYSIS

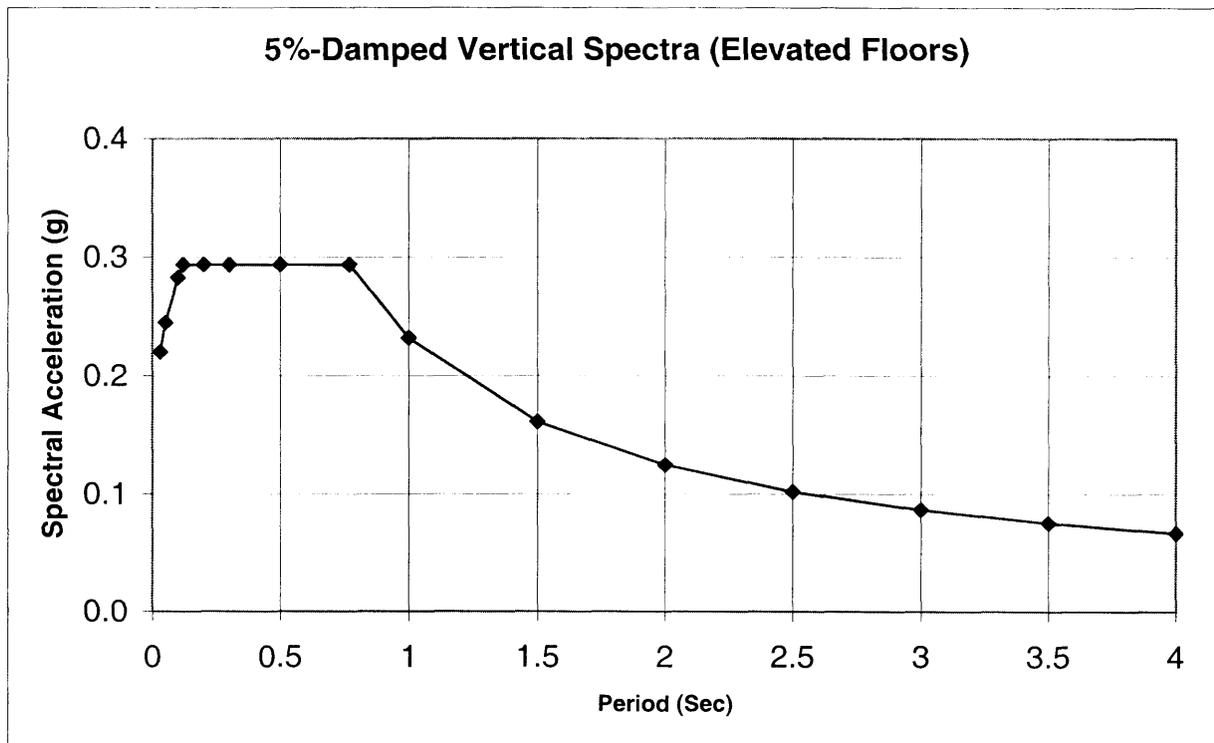
A response spectrum analysis shall be accomplished by using the site-specific ground response spectra or elevated floor response spectra listed below (shown in tabular form and graphically). The response spectra values provided are applicable for strength design and shall be divided by 1.4 for allowable stress design. The seismic load shall be considered acting simultaneously in three directions (two orthogonal and one vertical direction) by either the Square Root Sum of Squares (SRSS) method or the Component Factor Method (1/0.4/0.4).

Response Spectra at and Below Grade			
5%-Damped Horizontal Motions		5%-Damped Vertical Motions	
Period (sec)	Spectral Acceleration (g)	Period (sec)	Spectral Acceleration (g)
0.03	0.120	0.02	0.0843
0.05	0.143	0.05	0.110
0.1	0.200	0.1	0.128
0.2	0.273	0.2	0.148
0.3	0.276	0.3	0.144
0.5	0.197	0.5	0.0986
1	0.0890	1	0.0513
2	0.0364	2	0.0254
4	0.0179	4	0.0147



Elevated Floor (Above Grade) Response Spectra			
5%-Damped Horizontal Motions		5%-Damped Vertical Motions	
Period (sec)	Spectral Acceleration (g)	Period (sec)	Spectral Acceleration (g)
0.03	0.33	0.02	0.22
0.05	0.37	0.05	0.25
0.10	0.43	0.10	0.28
0.12	0.44	0.12	0.29
0.20	0.44	0.20	0.29
0.30	0.44	0.30	0.29
0.50	0.44	0.50	0.29
0.77	0.44	0.77	0.29
1.00	0.35	1.00	0.23
1.50	0.24	1.50	0.16
2.00	0.19	2.00	0.12
2.50	0.15	2.50	0.10
3.00	0.13	3.00	0.09
3.50	0.11	3.50	0.08
4.00	0.10	4.00	0.07
10.00	0.044	10.00	0.03





4.2 STATIC ANALYSIS

An equivalent static analysis may be used in lieu of the dynamic analysis, if a simple model can realistically represent the equipment. The seismic load shall be based on 1.5 times the peak horizontal and vertical spectral acceleration values and shall be considered acting simultaneously in three directions at the center of gravity of the equipment (two orthogonal and one vertical direction) by either the SRSS method or the Component Factor Method (1/0.4/0.4).

5 SUBMITTALS

The Seller shall submit a seismic report to the Buyer for review prior to fabrication of the equipment or prior to shipment of standard off-the-shelf items. For Seismic Category II equipment, the report shall describe the design of the seismic anchorage. For Seismic Category I equipment, the report shall describe the design of the seismic anchorage plus the seismic qualification of the equipment. For Seismic Category I equipment, the seismic report shall be approved, sealed, and signed by a registered professional engineer in the State of Colorado.

The report for both seismic categories shall include the following:

- a) Identification of equipment
- b) Seismic categorization of equipment, i.e., Seismic Category I or II

- c) General description of equipment supplemented by drawings, sketches, and photographs, as necessary
- d) Functional requirements
- e) Anchorage design calculations
- f) Drawing specifying location of anchor bolts; bolt, nut, and washer materials; total bolt lengths; bolt embedment lengths; projection from top of concrete; thread length; and all other information needed to procure and install the anchor bolts
- g) Conclusions

For Seismic Category I equipment only, the report shall contain the following additional items:

- a) Analysis method used
- b) Description of computer programs used and their validation
- c) Analysis results
- d) Calculations based on dynamic or static analysis method
- e) Analytical model used, to determine the effect of interaction between the equipment and attached piping